GRETA Progress Report

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GRETA is the proposed next generation Ge detector array which will have the unique feature of being able to track each gamma ray as it makes several interactions within highly segmented germanium detectors, and to reconstruct its properties. The *potential* capabilities of such a detector system are impressive: 1) a threshold at about 10 keV with a full-energy efficiency rising to nearly 100% around 200 keV, ~50% at 1 MeV and ~20% at 15 MeV; 2) localization of the first interaction point to within a few mm; 3) energy resolution of about 2 keV at 1 MeV; 4) determination of the arrival time to within a few nsec; 5) a resolving power about 1000 times that of Gammasphere or Euroball; and 6) the ability to handle event rates up to 10^5 per second, even for events having 20 or 30 coincident gamma rays.

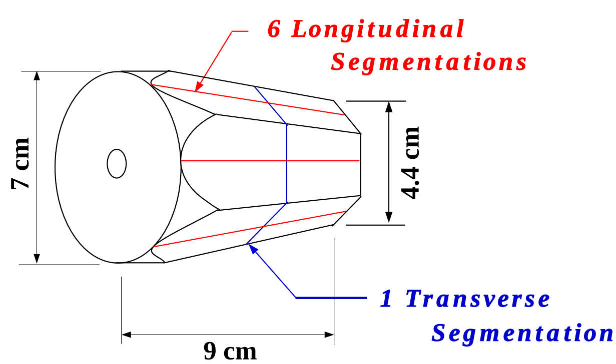
Since the initial concept, several years ago, we have made excellent progress towards the proof of principle of a GRETA detector, and in establishing methods to realize, in practice, the properties described above.

In principle the signals from the various segments should provide all the information necessary to fully reconstruct the event. The problem can then be split into two main areas, signal processing and tracking. Signal processing involves understanding how to extract, from the net and transient charge signals, the position and energy information for each gamma ray interaction point. Tracking concerns how well one can subsequently piece together the individual interactions to recover the full energy of the gamma-ray. Remember, in most cases, there are multiple gamma rays (up to 30) emitted simultaneously.

Simulations (based on Monte Carlo techniques) and preliminary tracking algorithms have shown, that for position resolutions of the order of 1-2mm, photopeak efficiencies of the order of 30% are likely achievable for $M_\gamma \sim 25$. This provides a "lower" limit. In the future we aim to investigate the use of more complex tracking algorithms (possibly based on neural networks) which could improve the efficiency so that it approached ~50% at 1 MeV.

Simulations of the signals for a segmented detector indicate that the magnitude of the induced currents in neighboring segments are sufficiently large to enable one to determine the position of the interaction point to within 1-2mm. The results of these simulations were compared with those obtained from a 12-segment Ge detector (the first "GRETA" detector prototype, and illustrated in the figure). The simulated signals were found to agree well with measured signals.

The next phase of the R&D involves investigating how to recover the information from a "complex signal", which arise when multiple interactions occur in a single or neighboring segment. A 36-segment prototype detector will be available in mid 1998, and will be used to determine the required geometry (sizes) of the segments.



GRETA Prototype Detector.